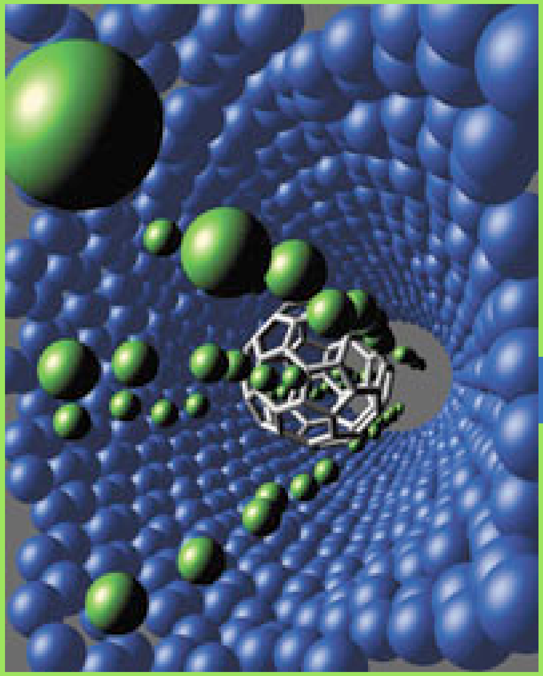
Advancing Nanoscience Education Workshop



A buckyball moving helium through a nanotube.
Courtesy of Dr Don Noid and Dr Bobby Sumpter

Overview and Introductions

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NanoSense Project

Agenda: Day 1 (Tuesday)

- Introductions, survey summary (9-10:15 am)
- Atlas of Nanoscience, Q&A (10:30-12 pm)
- Lunch and topic/group selection (12-1 pm)
  - Concepts, hands-on experiences, jobs, pathways
- Small working groups (1-5 pm)
  - Identify best practices, needs, approaches (c.f. NABC–Needs, Approach, Benefits, Competition)
  - Shift at 3, except moderator and recorder
- Report progress (5-5:30 pm)
  - 5 minutes each group on progress, plans for presenting tomorrow

Agenda: Day 2 (Wednesday)

- Breakfast (8:30)
- Groups finalize presentations (9-10 am)
  - On the order of 5-10 slides per group
- Groups present, 15 min each (10-11:30)
  - A few industry guests will join
- Discussion, reflection, next steps (11:30-12:30)
- Lunch and workshop evaluation (12:30-1:30)
  - Planning collaborations and joint grant proposals?
- Workshop report writing (afternoon)
  - Workshop staff, volunteers who are interested

Introductions

- Half a minute each
  - Name
  - Affiliation
  - Primary occupation
  - One or two sentences about your primary interests related to nanoscience education, and/or what you'd like to get out of this workshop

Survey Summary

- What should nanoscience education be?
  - undergraduate (6), high school (5), general public/out-of-school (4), teachers (1)
  - “true cross-disciplinary effort”
  - “exciting way to teach traditional science concepts”
- What should students know starting college?
  - Intro to chemistry (8), physics (6), biology (6), math (3), computer science (2), engineering (2), earth (1)
  - NSES and appreciation for practice, implications
  - Bonding, forces, atomic structure, friction, solubility
  - Problem solving/communication skills (3)

Survey Summary (cont.)

- What concepts should HS students learn?
  - Chemistry: organic; atomic structure, bonding, oxidation and reduction, adhesion, absorption, adoption, electrochem, periodic table
  - Physics: electronic and magnetic properties, electro-optical interaction, density, energy, forces
  - Biology: cells, molecules, DNA, protein
  - Math: calculate forces, metric system, scientific notation
  - Size and scale
  - Knowledge of applications
  - Problem solving, communication, how to learn

Survey Summary (cont.)

- Better taugh as interdisciplinary, integrated courses or through traditional disciplines?
  - Both, depends (8)
  - Prefer interdisciplinary (8) in ideal world
    - easier at upper level (1)
    - more interesting for students, especially females (1)
  - More examples in disciplines (3)
    - especially chemistry (2)
    - change is slow in academia, best bet is to integrate in disciplines (1)
  - “We lack research…whether or not an integrated or independent approach… is most effective”

Survey Summary (cont.)

- Most crucial foundational concepts?
  - Unique properties at nano vs. macro level (e.g., nanogold vs bulk gold) (4)
  - Surface technology/effects (4)
  - Size and scale (in time and space) (5)
  - Self-assembly (3)
  - Fabrication, control, tools (2)
  - Sense of statistics/averaging (2)
  - Measurement, bonding, forces, energy, quatum states, magnetism (~2)
  - Practical applications, jobs, integrated research (3)
  - Ethics, implications (2)

Survey Summary (cont.)

- Favorite examples?
  - Common examples
    - Self-cleaning clothes/nanofabrics (3)
    - Quantum dots, gold nanoparticles as sensors (3)
    - Clear sunscreen (2)
    - Energy from nano solar panels, clean hydrogen fuel (2)
  - Nanofilters, nanotubes, ferro fluids, STM
  - Need everyday hooks (clothes, hobbies, cool stories, curious phenomena)
  - Molecular Workbench modules
  - Nanofog, nanomayonnaise, Tobacco mosaic virus, T4 bacteriophage, self-cleaning toilets, gecko

Survey Summary (cont.)

- Role of lab experiences?
  - Labs critical (everyone), demos good/okay
  - Assist deep learning, facilitate soft skills
    - Interacting with others, reasoning
  - Should be integrated with lecture
  - Interactive playground
    - Computers, instruments, group tables, remote cameras
  - AFM lab/models, self-assembly demonstrations with magnets or foam, nanomanipulator to explore surfaces

Survey Summary (cont.)

- Recommended tools and materials
  - Molecular Workbench tools, Chemica (5)
  - MRSEC materials (3)
  - AFM (actual, and/or Scharberg's wood model) (2)
  - Nanomanipulator (2)
  - NanoZone (2), "It's a NanoWorld" exhibition
  - NanoKids (2)
  - Teacher-developed units (2)
  - NCSU simulations, UCLA nanotech labs
  - Visual Quantum Mechanics materials
  - ChemSense, NanoSense (tbd)

Survey Summary (cont.)

- Balance between academic learning, lab, and on the job training?
  - All equally important, tightly integrated (5)
  - Depends on level (5)
    - e.g., high school 40:50:10
    - college/adults slowly integrate more job training
  - What are the jobs? (2)
    - What internships are available to students?

Small Group Presentations

- Please fill out workshop evaluation
  - place in box on registration desk before you leave
- 9-10:15 am: 3 groups
  - Pathways and careers, concepts, hands on + TPD
- 10:15-12, 20 min presentations
  - Ideal practice (examples of materials, careers, etc.)
  - Problems, needs, or gaps
  - Core research questions
  - Grand challenges for the field
- Bob Tinker joining by phone, please use mic

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- 9-10 am: 3 groups
  - Pathways and careers
  - Concepts
  - Hands on and teacher professional development
- 10-12, 15 min presentations, possible slides
  - Ideal practice (examples of materials, careers, etc.)
  - Problems, needs, or gaps (don't dwell :)
  - Core research questions
  - Grand challenges for the field